3. *Notes on the* CRETACEOUS STRATA *of* NEW JERSEY, *and other Parts of the United States bordering the Atlantic.* By C. LYELL, Esq., M.A., F.R.S.

THE cretaceous and tertiary deposits of America, which intervene between the Alleghany mountains and the Atlantic, bear a great resemblance in mineral character to the sandy and argillaceous portion of the formations of the same age in the south-east of England. If all the white chalk, with its flints, together with the cherty beds of the green sand, were omitted, the remaining cretaceous strata in our island would consist of loose incoherent sand with green particles, red and highly ferruginous sandstones, white sands, and (in some places) beds of lignite; the overlying tertiary deposits, consisting of marls, clays, and variously coloured sands occasionally exhibiting green particles, like those of the green sand below the chalk; and as in the bottom of the London basin near Reading. Such, for the most part, is the succession of the beds in New Jersey; and, further south, in Maryland and Virginia, the Eocene strata are often as full of green particles as the cretaceous, so that they are only distinguishable by their fossils and relative position. Even the Miocene strata are sometimes, as in Virginia, of a blueish-green colour, and contain green particles of a similar kind. This fact alone of the identity in lithological character of the secondary and tertiary strata of the United States is calculated to put us on our guard against inferring that the green and ferruginous sands of New Jersey correspond in age to the lower rather than the upper part of the European cretaceous

system. It is scarcely possible, on recognising so many of the common organic forms which are familiar to us in connection with the cretaceous rocks on this side of the Atlantic, and seeing them occur in beds which have the exact mineral type of the beds below the Gault, not to feel a strong inclination to regard them as the equivalents of our green sand, and to consider the white chalk as wanting. But when we dismiss from our minds, as we ought to do, the bias derived from the consideration of the mineral aspect of the beds, and compare the fossils of New Jersey with those derived from the European chalk, we find the agreement upon the whole to be far greater with the beds occurring in Europe above the Gault, than with those which are found below it. We are indebted to Dr. Morton for having pointed out, in 1834, the general agreement of the organic remains of the American and European cretaceous fossils, while, and at the same time, he and Mr. Conrad correctly observed that almost all the species were different. He divided the strata of New Jersey into the ferruginous sand, which he compared to our green sand formation, and the calcareous strata, which he identified with the white chalk of Europe. Prof. H. D. Rogers has since divided the New Jersey cretaceous beds into five formations, which are very useful, topographically considered, but which may be overlooked in the present paper, because only two of them, namely, those alluded to by Dr. Morton, have as yet yielded a sufficient number of fossils to entitle them to rank as palæontologically distinct.

In an excursion which I made in New Jersey, in September, 1841, in company with Mr. Conrad, we went first to Bristol, on the Delaware, next, by Bordentown, to New Egypt, and returned by the Timber Creek, recrossing the Delaware at Camden. On this occasion I had an opportunity of examining the strata of both these formations, and I collected nearly all the fossil species described by Dr. Morton, together with some few additional ones. I shall now, therefore, briefly notice these two deposits and their fossils, and consider them in reference to their European equivalents.

Although in this part of New Jersey there is no white chalk with flints, so characteristic of rocks of the same age in Europe, it is still impossible to glance at the fossils and not be convinced that Dr. Morton was right, as before hinted, when in 1834 he referred the New Jersey deposits to the European Cretaceous era, and remarked that the American species of shells were nearly all new or distinct from those before described, and yet very analogous to those of the chalk already known. Of the two well-marked subdivisions of the Cretaceous system the lower consists in great part of green sand and green marl, and was supposed by Dr. Morton, as already mentioned, to be the equivalent of the English green sand, while an upper or calcareous rock, composed chiefly of a soft straw-coloured limestone with corals, was thought to correspond with the white chalk of Europe. But after carefully comparing my collection, comprising about sixty species of shells, besides

many corals and other remains, I have arrived at the conclusion that the whole of the New Jersey series agrees in its chronological relations with the European white chalk, or, to speak more precisely, with the formations ranging from the Gault to the Maestricht beds inclusive. Among the shells, in determining which I have been assisted by Professor E. Forbes, not more than five out of sixty seem to be quite identical with European species; but several others approach very near to, and may be the same as Europeans; and at least fifteen may be regarded as good geographical representations of well-known chalk fossils belonging for the most part to beds above the Gault in Europe. There are a few very peculiar forms among the American testacea, such as *Terebratula Sayii* Morton; and I found among the univalves a Bulla, but casts of the genus had previously been mentioned by Dr. Morton, and although not yet known in the European chalk a species occurs on the Continent in beds of the Jurassic system.

In the upper or straw-coloured limestones, I found on the banks of the Timber Creek, twelve miles south-east of Philadelphia, six species of corals* and several echinoderms, chiefly allied to *upper* cretaceous forms. The same calcareous formation also abounds in Foraminifera characteristic of the chalk, comprising, among others, the genera *Cristellaria*, *Rotalina*, and *Nodosaria*. Besides the shells there are also several remains of fishes, and of the series obtained by myself all those referred to the genus *Lamna* resembled species occurring in our chalk. They have been examined for me by Sir P. Egerton. One of them seems to approach very closely to *Lamna appendiculata*, and another comes very near to *Galeus pristodontus*; and indeed, if we may judge by so few specimens, seem identical. These are fossils of our upper chalk in Europe. There are also several forms of *Carcharias* not very unlike some tertiary species given me from the New Jersey chalk, several of which are figured by Dr. Morton; I will not dwell upon these however, since in Europe also there are many of the cretaceous Squalidæ which can scarcely, when the teeth alone are considered, be distinguished specifically from tertiary fossils.

There are three Saurian vertebræ in the New Jersey green sand in the collection of the Geological Society, which I have submitted to Mr. Owen's inspection. One of these, from the green sand of Mullica Hill, is the anterior dorsal vertebra of the Mosasaurus. Another is the posterior cervical vertebra of a Pliosaurus, a genus which Mr. Owen has constituted to include a portion of the Plesiosauri, and which approach still more nearly to the true Saurians. The vertebra in question resembles very closely that of *Pliosaurus brachydeirus* of the Kimmeridge clay. Until very lately, the Plesiosaurian type was not known higher in the series than in the Oolites; but it has now been shown to ascend to the chalk of Europe, so that its occurrence in the New Jersey strata is in strict accordance with European analogies. The third specimen (pre-

* These have been described by Mr. Lonsdale, and the description and figures will be given at the end of the present paper.

sented, I believe, by Professor H. D. Rogers) is labelled, "Woodstown, New Jersey;" a locality where those beds occur to which the great mass of shells before alluded to belong. It is a vertebra, penetrated by the green particles of the sand. Mr. Owen refers this to the dorsal vertebra of a crocodile of his *Procœlian* division, or those which, like the recent crocodiles, have the concavity in the forepart, and the convexity behind. This fact is important, as hitherto the Procœlian crocodiles in Europe have not been found in beds older than the eocene.

In concluding these remarks on the ferruginous and green sand formation of New Jersey, I may observe that the identification of four or five species out of sixty fossil shells with European cretaceous fossils would give an agreement of about seven per cent., which is by no means a small amount of correspondence, when we consider that the part of the United States above alluded to is distant between 3000 and 4000 miles from the chalk of Central and Northern Europe, and that there is more than 10° difference in the latitudes of the two districts compared, on the opposite sides of the Atlantic. It may doubtless be true, that the influence of temperature during the Cretaceous period was less powerful in limiting the range of species than it is now; and that the same forms prevailed more uniformly from India to Sweden, than they do at present. Nevertheless, the cretaceous fossils of Northern and Southern Europe differ sufficiently to show that the climate had then no small influence in causing distinct geographical provinces of species; and it seems natural that those species which are very abundant in Europe, such as *Belemnites mucronatus*, or those which have a great vertical range, such as *Pecten quinquecostatus*, should be the fossils found, if any, to recur in a distant part of the globe.

In the next place I proceed to give some account of the upper fossiliferous division of the New Jersey cretaceous deposit, which is for the most part arenaceous, but contains, in many places, layers of limestone and calcareous sand, with corals slightly aggregated together. It has been traced by Mr. Rogers to a distance of about 60 miles in a north-east and south-west direction, from Prosper Town to near Salem, having rarely a breadth of half a mile, and the thickness being from 6 to 20 feet. Its importance is derived, geologically speaking, from its fossils, and, in an economical point of view, from its affording the only lime procurable in this district. I saw the formation in question, on the banks of Timber Creek, a stream which flows into the Delaware, three miles below Philadelphia. The principal locality is twelve miles S. E. of Philadelphia, about a mile and a half south of the village of White Horse, in Gloucester County, New Jersey. Here a bed of soft calcareous stone, about 20 feet thick, is seen made up, in great part, of corals of the genera *Eschara*, *Escharina*, *Cellepora*, *Tubulipora*, and others*, together with the remains of echinoderms, such as *Cidaris* and *Spatangus*. It contains also some shells, as *Scalaria annu-*

* See the description of these corals by Mr. Lonsdale, in the Appendix.

lata, *Gastrochæna*, and *Teredo*, the whole indicating the sandy bottom of a shallow sea. I was so strongly reminded of the coralline crag of Sudbourn, and other places in Suffolk, when examining this rock, that I had some difficulty at first in persuading myself that it was not a tertiary deposit. It is, in a great part, a mass of white calcareous sand, more or less aggregated together, and the upper surface has been irregularly scooped out and rendered undulating, and is covered with a newer deposit of red clay and gravel, without fossils, the surface of which is even and level. This white sand and limestone pass downwards into light-green and ferruginous sand, with quartzose grains.

Near Hornerstown, I saw, on a branch of the Timber Creek, to which Mr. Conrad conducted me, a bed of this coralline aggregate, 8 feet thick, resting on the green sand or lower deposit before mentioned, with its characteristic fossils.

We have now to consider whether the calcareous or upper formation has been referred with propriety to the chalk. Mr. Forbes has examined the Echinoderms, and is of opinion that they are decidedly analogous to cretaceous forms. One of the species of *Spatangus* belongs to the same group as *S. subglobosus* of Goldfuss, a group which forms the genus *Holaster* of Agassiz, and which that naturalist regards as very characteristic of the upper part of the Cretaceous system.

One also of two species of Cidaris is allied to *C. vesiculosus*, and to other upper cretaceous species of Europe.

Dr. Morton had already observed, in regard to the corals, that some of the species resemble a Maestricht fossil, figured by Goldfuss; and the reader is referred to Mr. Lonsdale's comments on this subject in the Appendix.

The fossil called by Dr. Morton "*Belemnites ambiguus*," though probably not related to the Belemnite, is closely allied to a fossil which I have collected myself in the chalk of Sweden, associated with *Belemnites mucronatus*.

The last-mentioned, or upper of the two fossiliferous formations of New Jersey, has been called by Dr. Morton and Mr. Conrad the Medial Cretaceous, because there are others still higher in position in the Southern States, which they refer to the chalk period. One member of these, a white limestone, seen extensively on the Santee canal, and in other parts of South Carolina, as well as at Jacksonborough and Shell Bluff in Georgia, I have shown, in a former communication to the Society, to be Eocene tertiary. Another portion, called the Nummulite limestone of Alabama, I have not examined, and can therefore offer no opinion respecting it.

Upon the whole, the collection of fossils which I made in New Jersey confirms the principal conclusion to which Dr. Morton arrived, that there is a remarkable generic accordance between the fossil mollusca, corals, echinoderms, fish, and saurians of the cretaceous group, in New Jersey and in Europe. But the general analogy of the generic, and the identity of some specific, forms, which Mr. Forbes and Mr. Lonsdale have assisted me in comparing,

has led me to refer all the fossiliferous formations of New Jersey to that part of the European series which ranges from the Maestricht beds to the gault inclusive.

North Carolina.

Of the same age are certain strata in North Carolina, at a place called Lewis's Creek near South Washington, forty miles north of Wilmington, and 340 geographical miles south-west of New Jersey, where I found *Belemnites mucronatus*, *Ostrea vesicularis*, *O. subspatulata* (a remarkable and new species figured in the Appendix), *Cellepora tubulata*, and other fossils.

The association of *Cellepora tubulata*, which abounds in the upper cretaceous formation of New Jersey at Timber Creek with *Belemnites mucronatus* in this locality of South Carolina, is important, as helping to show the near relation of the coralline limestone of New Jersey to the green sand containing Belemnites.

Georgia.

Some fossils have been communicated to me by Dr. Cotting, from Georgia, which make it probable that there are cretaceous strata there, lower than those of New Jersey; as among them are a *Pholadomya* and an *Ammonite;* both of which Mr. Forbes finds to be closely allied to certain Neocomien species from Neuchâtel.

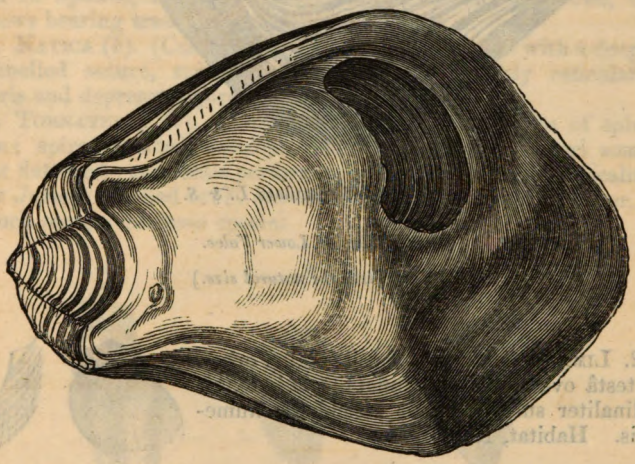
In the collection of Mr. Conrad, from Alabama, I saw a species of Hippurite, derived from the cretaceous strata of that State, which I believe is the only example of any fossil of the Rudist family derived from the cretaceous rocks of North America. It affords another point of analogy between the cretaceous fauna co-existing on opposite sides of the Atlantic.

It is interesting to find, as the result of this investigation, that the marine fauna, whether vertebrate or invertebrate, testaceous or zoophytic, was divided at the remote epoch under consideration, as it is now, into distinct geographical provinces, although the geologist may every where recognise the cretaceous type, whether in Europe or America (and I might add India). This peculiar type exhibits the preponderating influence of a vast combination of circumstances prevailing at one period throughout the globe, circumstances dependent on the state of the physical geography, climate, and organic world, in the period immediately preceding, together with a variety of other conditions.

Appendix I. — *On the* Fossil Shells *collected by* Mr. Lyell *from the Cretaceous Formations of* New Jersey.

1. *Description of New Species.* By Professor Edward Forbes.

Most of the fossil shells (amounting to sixty species) collected in New Jersey during Mr. Lyell's excursion with Mr. Conrad have been already described in Dr. Morton's excellent work. The following, however, are new species:—



Ostrea subspatulata *L. & S.*

Interior of the Lower Valve.

[*Two thirds the natural size.*]

1. Ostrea *subspatulata.** Lyell and Sowerby. Shell obovate somewhat trapeziform; generally thick; higher than wide; narrower at the dorsal than at the ventral or basal end, which is turned downwards at an obtuse angle; somewhat foliaceous externally; muscular impression placed very near the base. Locality, Lewis's Creek, South Washington, North Carolina.

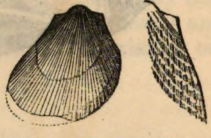
* Ostrea obovata, spatulata; valvâ inferiore, convexâ, arcuatâ, posticè crassissimâ; superiore subdepressâ.

Ostrea subspatulata *L. & S.*

Side View of Lower Valve.

[*Two thirds the natural size.*]

2. Lima *reticulata*. Lyell and Forbes. L. testâ ovatâ, obliquâ, inflatâ, tenui, longitudinaliter sulcatâ, sulcis reticulatis, numerosis. Habitat, Nov. Jersey.

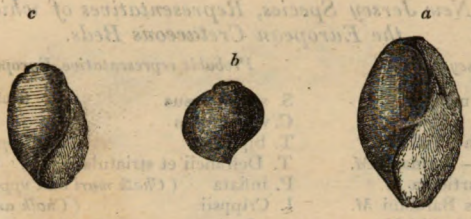


Lima reticulata *L. & F.*

3. Terebratula *Vanuxemiana*. Lyell and Forbes. T. testâ suborbiculare, valvis bicarinatis, longitudinaliter costatis, costis

Terebratula Vanuxemiana *L. & F.*

intermediis minoribus, valvâ superiori convexâ, areâ late triangulare, foramine magno, valvâ inferiori convexiusculâ, margine frontali subbisinuatâ. Habitat, Nov. Jersey.



a. Bulla Mortoni.
b. Natica.
c. Tornatella.

4. Bulla *Mortoni* (*a*). (Cast.) Ovate, inflated, resembling in form B. *hydatis*, spire concealed, surface spirally furrowed, the furrows bearing traces of punctation.

5. Natica (*b*). (Cast.) Of a small globular species with a deeply channelled suture, spirally sulcated, and obsoletely reticulated whorls and depressed spire. Locality, New Jersey.

6. Tornatella (*c*). (Cast.) Oblong, bearing traces of spiral striæ; spire exserted, subdepressed; sides of body-whorl somewhat flattened; columella perforate; aperture lanceolate. Locality, New Jersey. Allied to *T. bullata* of Morton, which, however, is a much more ventricose species.

Casts of Voluta.

7. Voluta. (Casts.) *a*, Shell linear, lanceolate, whorls smooth. *b*, Shell ovate, whorls smooth. *c*, Shell ovate, whorls angular above, distant ribs.

Note. — The figures are all of the natural size, except the Ostrea, which is two-thirds in linear dimensions.

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2. *List of Species common to the American and European Cretaceous Systems.*

Ostrea larva (O. falcata *M.*)
—— vesicularis
Gryphœa costata
Pecten quinque-costatus
Belemnites mucronatus

3. *List of New Jersey Species, Representatives of which occur in the European Cretaceous Beds.*

New Jersey Species.	*Probable representative European Species.*	Geological locality in Europe.
Spatangus n.s.	S. subglobosus	
Cidaris	C. vesiculosus	
Terebratula fragilis *M.*	T. biplicata	(*Upper green sand*)
——— floridana *M.*	T. Defrancii et striatula	(*Upper chalk*)
Plicatula urticosa *M.*	P. inflata	(*Chalk marl and upper green sand*)
Inoceramus Barabini *M.*	I. Crippsii	(*Chalk and green sand*)
Cucullea vulgaris *M.*	?	
Trigonia thoracica *M.*	T. alæformis	(*Green sand*)
Pholadomya occidentalis *M.*	P. gigantea	(*Lower green sand*)
Phorus leprosus	P. canaliculatus	(*Lower chalk*)
Scalaria annulata	S. Dupiniana	(*Gault*)
Natica petrosa *M.*	N. excavata	(*Gault*)
Voluta	Several lower chalk species.	
Hamites arcuatus	?	
Ammonites placenta	A. clypeiformis	
Baculites ovatus	B. anceps.	

4. *List of Peculiar Forms found in the New Jersey Cretaceous Formations.*

Terebratula Sayii *M.*
Ostrea subspatulata *n. s.*
Crassatella vadosa *M.*
Venilia Conradi.

Notice of the Foraminifera. By Mr. Lyell.

a. Rotalina. (*d.* nat. size.)
b. Cristellaria. (*c.* nat. size.)

The above are figures of the two genera of Foraminifera from the upper beds at Timber Creek, alluded to in the paper.

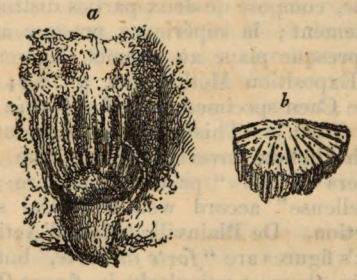
I am not aware that any attention has hitherto been paid to the fossil foraminifera of the American cretaceous strata, to which I find no allusion in Dr. Morton's works. They are very abundant in the coralline rock of Timber Creek. Mr. Forbes has examined some of them for me, and these belong to the genera Cristellaria, Rotalina, and Nodosaria. All these genera occur in the chalk of Europe. One of my American species of fossil Cristellaria is specifically identified by Mr. Forbes with *C. rotulata* of D'Orbigny, which occurs in England, France, and Germany, ranging from the upper greensand to the white chalk. It is another instance of species found most abundantly in Europe, recurring in the American chalk. There are two other species of the same genus at Timber Creek, one of them very large. There are two species of Nodosaria. The Rotalina, which is very abundant, is closely allied to a species of our chalk.

APPENDIX II. — *Account of* SIX SPECIES OF POLYPARIA *obtained from Timber Creek, New Jersey, and described by* WILLIAM LONSDALE, Esq. F. G. S.

THE following is a list of the species :—

1. Montivaltia atlantica *Lonsdale* (Anthophyllum atlanticum *Morton*).
2. Idmonea contortilis *Lonsdale*.
3. Tubulipora Megæra *Lonsdale*.
4. Cellepora tubulata *Lonsdale*.
5. Escharina ? sagena *Lonsdale* (Flustra sagena *Morton*).
6. Eschara digitata *Morton*.

1. MONTIVALTIA ATLANTICA.



a. Nearly perfect specimen, exhibiting the lamelliferous or upper portion in its true position, and the inferior hollow cone.
b. Portion of the upper surface slightly worn down, to show the characters of the lamellæ.

Inversely conical; lower or non-lamelliferous portion nearly equal in length to the upper or lamelliferous; enveloping crust extending nearly to the superior termination of the cone; lamelliferous portion variable in form; lamellæ very numerous; centre, contorted plates terminating inferiorly in a distinct umbilicus or boss; superior termination of the cone nearly flat.

This coral is described by Dr. Morton under the name of ANTHOPHYLLUM ATLANTICUM. (Silliman's Journ. vol. xviii. pl. 1. f. 9, 10. Essays on Org. Rem. &c., p. 61. 1829. Journal Acad. Nat. Sc. Philadelphia, vol. vi. pl. viii. f. 9, 10. pp. 123, 124. 1830. Synopsis Org. Rem. &c. pl. i. f. 9, 10. p. 80. 1834.)

Dr. Morton states (Essays, pp. 61, 62. Synopsis, p. 80.) that he derived his characters of the genus Anthophyllum from Goldfuss; and the lamelliferous portion of the coral under consideration, as represented in Dr. Morton's excellent figures, bears a strong general resemblance to some of Goldfuss's species (Petref. pl. xiii. f. 10, 11. pl. xxxvii. f. 15.). The fossil is probably generically identical with that represented in pl. xxxvii. f. 15. There is also a general

agreement in Dr. Morton's figure 10. (pl. i. Synopsis) with Schweigger's *Anthophyllum cyathus* (Beobachtungen, Tabular Arrangement, vi.), particularly as given in Esper (Pflanzenthiere, Madrep. tab. xxiv.); but the American fossil, when preserved in its true position, clearly differs from the generic characters proposed by Schweigger, and adopted with various modifications by succeeding authors, including Goldfuss. The *Anthophyllum cyathus*, as well as the corals typical of the four other divisions of Schweigger's comprehensive genus, are lamelliferous throughout, whereas the American fossil, as beautifully shown in one of the Timber Creek specimens (*a*), consists of an upper lamelliferous portion or nucleus, and an inferior non-lamelliferous portion or hollow inverted cone.

This great peculiarity of structure apparently agrees with Lamouroux's characters of his genus *Montivaltia:* "Polypier . . . . presque pyriforme, composé de deux parties distinctes, l'inférieure ridée transversalement; la supérieure presque aussi longue que l'inférieure, . . . presque plane au sommet, légèrement ombiliquée et lamelleuse" (Exposition Méthodique, p. 78.); and in his observations on the Caen specimens of *Montivaltia* he says, "elles sont géodiques" (ibid.). This peculiar structure would agree perfectly with the hollow inverted cone of the American coral, and the characters of the "partie supérieure légèrement ombiliquée et lamelleuse" accord well with the structure of the lamelliferous portion. De Blainville (Man. d'Actinologie, p. 336.) says, Lamouroux's figures are "*forte inexacte*," but there is enough of resemblance in them, particularly in figure 9. (Plate 79.) to support a generic agreement with the Timber Creek fossil, the "partie inférieure, ridée transversalement," being represented in the American specimens by the cast of the hollow cone, and the higher extension of the envelope being considered only a specific difference. Lamouroux's coral figured by Guettard (Mém. iii. p. 466. pl. 26. f. 4, 5.), but named by De Blainville *Montivaltia Guettardi* (De Bl. Man. d'Actinol. p. 336.; see also *Anthophyllum Guettardi*, p. 340.), bears even a closer resemblance to the Timber Creek specimens. Guettard graphically compares it to a "cupule de gland de chêne."

Dr. Morton, in his careful researches for analogous cretaceous fossils, refers to Faujas St. Fonds's figures of Maestricht corals, particularly to Pl. xxxviii. f. 1. 5. (Hist. Nat. de la Mont. de St. Pierre de Maestricht). Between those figures and the American coral there is a great general similarity; but a rigid comparison will show that there are important differences in the structural details, particularly in the centre of the apparently lamelliferous portion. The Maestricht fossils, or casts, are moreover wholly siliceous; and therefore, as they do not exhibit any traces of the original lamellæ, they cannot lead to the inference that the original coral consisted of two distinct structures. It is most probable that those casts represent only the terminal cup of an ordinary lamelliferous polypidom. It was the preservation of the lamellæ in the

upper part, and the total want of any trace of them in the lower, which led to the belief that the Timber Creek specimens belong to the genus Montivaltia.

The total length of the finest specimen (*a*, see figure), is about $1\frac{1}{2}$ inches, and the greatest breadth nearly $\frac{3}{4}$ of an inch; the two portions, as before stated, are of about equal length. The whole form of the coral is an inverted cone, terminating downwards in a bent point. The lamelliferous portion is cylindrical, or slightly contracted towards the base, and there is often a tendency to bend to one side. The lamellæ are very numerous, amounting probably to eighty; and are represented in well-preserved specimens by layers of calcareous spar. They were apparently of unequal dimensions; and their lower terminations are distinctly rounded or semicircular without any signs of fracture, and, consequently, of having extended downwards into the existing hollow cone. The sides of the lamellæ were apparently hispid, rows of indentations occurring in the earthy matter, which filled the intervening spaces of the original coral. The superior terminations of the lamellæ were unequal, certain of them, probably twenty in all, protruding above the others; and these range inwards, uniting with the central contorted plates. The characters exhibited in a slightly worn-down specimen prove also that the upper termination of the coral was not cup-shaped, but flat, with possibly a slight central depression (*b*).

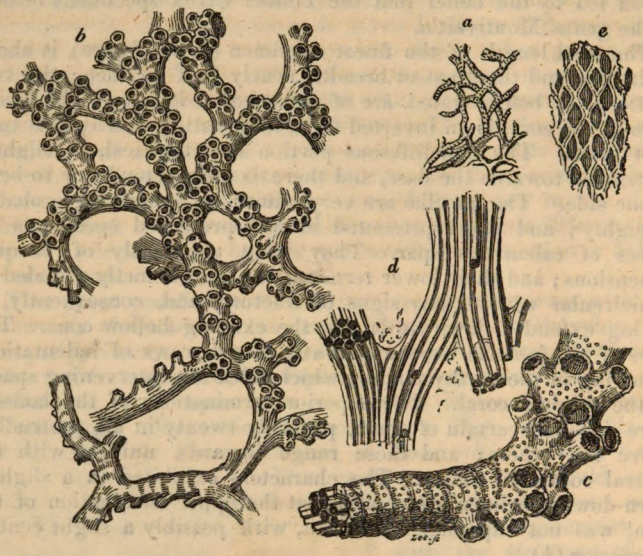
The centre of the lamelliferous portion consists of plates more or less horizontally contorted in the body of the cylindrical mass, and vertically at the superior and inferior terminations, forming in the latter position either a marked central rugose depression as shown in Dr. Morton's figures (*loc. cit.*), or a subordinate projecting cone (*a*).

The interspaces between the original lamellæ are occupied by earthy casts, constituting a very conspicuous portion of the coral; and from their well-defined rounded edge, as well as their decided termination downwards, they might be considered as the true lamellæ. It is clear, however, from their bearing the impression of hispid surfaces, that they are mere casts, formed while the original lamellæ existed. The material of which they consist is more or less argillaceous, and includes numerous foraminiferæ.

Of the nature of the portion represented by the hollow cone, no opinion can be offered. That it possessed a certain amount of solidity, and had structural details which resisted, for a time, decomposition, is evident from the earthy matter which filled the spaces between the lamellæ not having penetrated downwards into the cone, and from the marked characters of these casts. It is clear, also, from the preserved vestiges of the crust which enveloped the lamelliferous portion, as well as from the surrounding cavities mentioned by Dr. Morton, that the external wall or integument must have been thin.

Locality. Timber Creek.

2. IDMONEA CONTORTILIS *Lonsdale.* Sp. n.



a. Branches natural size.
b, Portion of the same magnified, and exhibiting the contorted mode of growth.
c. Part of a branch more highly magnified, to show the pores in the surface.
d. Magnified portion of the reverse side (*e.* nat. size), exhibiting the range of the tubes, exposed by fracture.

Branches compressed, bifurcated, contorted and anastomosed; tubular openings projecting, variously grouped; no marked, continuous, central line between the groups; reverse surface slightly convex, furrowed transversely, and streaked faintly by the separating walls of the tubes.

In the absence of the central line or medial ridge, and of a regular bilateral arrangement of the tubular openings, this coral differs from the generic characters of Idmonea as given by Lamouroux (Exp. Méthodique, p. 80.), and repeated by Milne Edwards (Ann. Sc. Nat., 2d series, vol. ix. Zool.); but it agrees in the general distribution of the openings with the latter author's enlarged figure of *Idmonea transversa* (loc. cit. Pl. ix. fig. 3.; likewise Recherches sur les Polypes; Mémoire sur les Crisies, &c.); De Blainville also, in his description of the genus, says, the openings are disposed "en demi-anneau ou en lignes brisées" (Man. d'Actinol., p. 419.). There is a slight resemblance between the Timber Creek coral and the *Cellepora echinata* of Goldfuss (Petref. xxxvi. f. 14.), an Astrupp tertiary fossil, but which is said to be attached to a Terebratula.

The branches are slightly convex on both sides (see figures), and so greatly contorted that the reverse surface of some portions of a specimen are completely turned round. The tubular openings

project more or less, and are variously grouped, but with a tendency to a transverse linear arrangement. The furrows between the openings are smooth, or but faintly traversed by longitudinal lines, marking the range of the tubes; they are, moreover, minutely porous (*c*). On the reverse side very small pores may also be detected, though not generally, in consequence, probably, of the thickening of the external layer by matter secreted through them. This remark applies likewise to those between the tubular openings. On the inner surface of the layer, forming the reverse side, the pores are very distinct and numerous.

The tubes are angular (*d*), and have a considerable range, bending conformably to the contortions of the branches. The substance of their walls is not often well preserved, but where it is retained microscopic foramina may be also detected.

No changes, incident upon age, have been noticed, except the probable thickening of the outer layers on both surfaces: no cases of young tubes have been observed.

Locality. Timber Creek, New Jersey.

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3. TUBULIPORA MEGÆRA *Lonsdale.* Sp. n.

a. The coral of the natural size, to exhibit the general resemblance to the smaller species of Alecto.

b. Portion magnified, showing the characters of the attached fasciculi and the tubercular openings.

Dichotomous, fasciculi of tubes slightly conical; mouths of the tubes united in a round, slightly projecting tubercle.

To the unassisted eye this coral presents a perfect agreement with Lamouroux's genus Alecto, consisting apparently of simple tubes, and not of fasciculi of 2 to 5 tubuli.

The fasciculi or branches gradually increase in breadth between the points of bifurcation, the broadest part being adjacent to the mouths. Externally they are round, but the outline of the surface is apparently modified by the papillæ of the Echinite to which they are attached. The tubuli, where they have been accidentally exposed, are arranged laterally. The tubercle, composed of the mouths, or probably the abraded base of the vertical portion of the tubuli, is reflected vertically upwards, or is inclined at a consider-

able angle: it is cylindrical, and much less in diameter than the adjacent portion of the fasciculus. The mouths themselves are not arranged in a line, or in the same manner as the tubuli, but grouped so as to occupy the least possible breadth; they are small, rounded on the exterior side, but flattened or angular at the points of contact.

Locality. Timber Creek.

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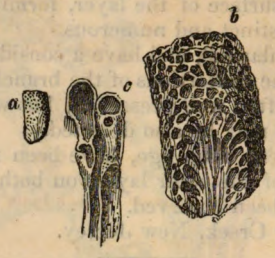
4. CELLEPORA TUBULATA *Lonsdale.* Sp. n.



a. Portion of a branch of the natural size.
b. The same magnified, to show the elongated characters of the central cells.
c. Magnified, elongated cells from the interior of the branch, with a perfect mouth and foramen under the proximal lip. The microscopic pores in the walls of the cells are likewise given.

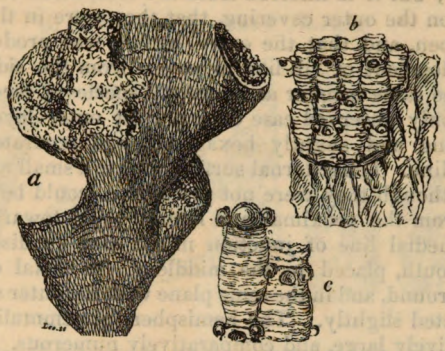
Branched; branches round, dichotomous; cells irregularly aggregated, ovoid elongated or tubular; mouth semicircular, large; proximal lip straight with a minute foramen in the centre.

The external surface of the branches rarely presents cases of perfect cells. Where they occur, they exhibit the usual ovoid form, and the mouth is well defined, being bounded completely by the distal arched covering of the cell; there is also a foramen under the proximal lip. More generally the surface presents a confused congeries of circular or angular openings, leading into ovoid cells. Internally, the branches exhibit, when fractured transversely or longitudinally, a perfectly tubular character in the cells comprising the axis of the branch (*b*), the cells being of great length and angular from lateral interference or compression; but towards the distal termination, as displayed in one instance, the ovoid form of the ordinary condition is assumed, by a swelling outwards, and the mouth is bounded by a regularly curved surface, the proximal lip being also supplied with a minute foramen (*c*). The prevailing form of the cells composing the mass of the branches is, however, ovoid, but variable in outline as well as in size and position. The cells are also much more numerous than is represented in fig. *b*.

The minute foramen on the proximal lip was probably connected with the base of the spinous process, so frequently exhibited in recent and fossil species of Cellepora. On the surface of the sides of the tubular cells, and also on those of the ovoid, minute connecting foramina may be detected, well defined, and occasionally bounded by an opaque, or thickened, circular line.

Localities. Lewis's Creek (South Washington, North Carolina), and Timber Creek.

5. Escharina*? sagena.



a, General mode of growth, the exposed surface being the reverse side of a layer of cells.

b, Cells composing portion of an inner layer; also reverse side of the opposite layer.

c, Cells forming part of an outer layer; one of them with a gemmuliferous vesicle.

Foliaceous, cells in two or more opposite layers, successively encrusting, but separable; cells oblong or hexagonal, defined by a slightly depressed line, arranged in alternate rows, but not conformably in succeeding layers; outer surface of cell nearly flat, ribbed; mouth at the distal extremity, small, round; gemmuliferous vesicle large, hemispherical; accessory foraminated vesicles two, over the mouth.

In the notice of this coral (Synopsis, &c. p. 79., pl. xiii. f. 7.), Dr. Morton describes it under the name of *Flustra sagena*, but adds, "perhaps it is an Eschara."

This polypidom differs from described species of Escharina in its free, foliaceous mode of growth, in being composed of several opposite, enveloping layers, and in the facility with which the dorsal surfaces may be detached; but it has been thought advisable not to propose a new generic name for this and analogous fossil corals, the characters of Escharinæ being considered to be not fully ascertained. The *Cellepora nobilis* of Esper (Pflanzenthiere, Cellep. tab. vii.) exhibits similar consecutive layers of cells, but arranged around a cylindrical nucleus and not in free plates.

The foliations are of considerable dimensions, and are variously contorted (*a*), and sometimes anastomosed. The layers are thin, but when numerous the foliations exhibit considerable thickness. Specimens presenting the opposite layers in their original position are not common, in consequence of the facility with which they separate along the medial plane. Portions only of successive layers are also to be detected, and not very frequently. The perfect outer layer was noticed in only one instance. (*c*)

* *Escharina* Milne Edwards; *Lepralia* Johnston.

Of the earliest state of the cells no positive information has been obtained* ; but it is inferred from the ribs, more or less distinctly traceable on the outer covering, that they were in the young stage entirely open, and that the outer surface was produced by a uniform development of rib-like processes from the side-walls of the cells, in the same manner as in certain species of recent *Escharina*.

In the only observed case of a perfect outer layer(*c*), the cells were oblong and slightly hexagonal, and separated by a faint, depressed line. The external surface was, to a small extent, convex ; and ribs, though they were not prominent, could be detected, converging from the proximal and lateral walls towards the centre; and the medial line of junction might also be discovered. The perfect mouth, placed in the middle of the distal extremity, was small and round, and in the same plane with the outer surface, but the lips projected slightly. The hemispherical gemmuliferous vesicles were relatively large, and comparatively numerous. They were situated immediately over the mouth, and they altered the position of that orifice from a horizontal to an inclined position. The accessory foraminated vesicles were variable in outline but constant in occurrence and situation, springing from the sides of the mouth, and increasing in size as they ranged upwards and outwards. The foramen was often well defined. From the position of these vesicles, the breadth of the distal extremity was apparently much increased.

In subjacent or older layers (*b*) the substance of the coral was not often preserved, having been detached with the overlying series, and leaving only calcareous casts of the interior of the cells; but where it is retained, there were no marked differences of characters, as far as observation extended, except in the absence of gemmuliferous vesicles. The mouths did not appear to have been filled up by the animal, and the foramina of the accessory vesicles were occasionally open: the depressed lines between the cells were also preserved.

In fragments which exhibited only casts of the cells, the indications of the ribs were sometimes as strong as on the outer surface, and the form of the mouth was well shown; but there were only very slight indications of the accessory vesicles.

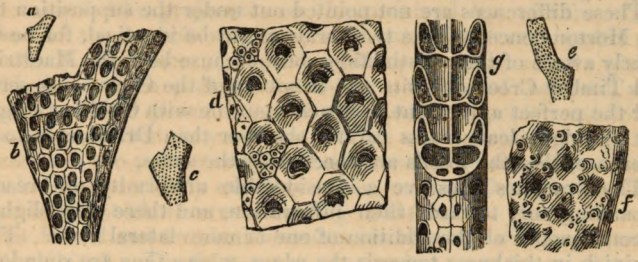
Of the lateral connecting foramina nothing decided was observed in consequence of the perishable state of the layers; but if the imperfect cells mentioned in the note * belonged to *Escharina (?) sagena*, the foramina were numerous.

The dorsal surface along the medial plane of separation (*a*) very much resembled that of *Flustra foliacea*, when artificially exposed.

Locality.—Timber Creek.

* On the surface of one specimen, some immature cells, consisting of only the dorsal and side walls, were observed, occupying the exact position of an ordinary layer of *Escharina sagena*, but there were no proofs that they belonged to that species; and all attempts to connect their structural details with those of the coral under consideration failed.

6. Eschara digitata *Morton.*



a. b. Bifurcated branch, natural size and magnified, consisting of immature cells with the outer surface almost wholly open, and with no indications of a distinct mouth.

c. d. Portion of a bifurcated branch, with mature cells. To the right of figure *d* is a cell with an uniformly depressed surface, and conjectured to have performed the office of a gemmuliferous vesicle: to the left are irregularly foraminated cells.

e. f. Portion of an aged branch, with the characters of the mature cells obliterated by external additions and the production of irregular tubercles.

g. Magnified side view of a branch, to show the position of the lateral connecting foramina within the cells; and of the small or defective cells exhibited also in the edge of figure *d.*

Branched, branches compressed, dichotomosed; cells hexagonally pyriform, separated by a fine lineal groove; surface sloped inwards from the periphery; mouth semicircular or semi-oval; no accessory or gemmuliferous vesicles observed; lateral connecting foramina two, terminal one.

See Dr. Morton's Synopsis Org. Rem., Cretaceous Group, United States, p. 79. pl. xiii. f. 8. 1834.

Dr. Morton states that this fossil strongly resembles *Eschara dichotoma* of Goldfuss (Petref. tab. viii. f. 15.), a Maestricht coral, and there is a perfect agreement in the mode of growth, as well as a general resemblance in the form of the cell; but a considerable difference, in structural details, is visible when the two fossils are compared. The cells in both cases are hexagonal, but the sides of those composing the Maestricht *Eschara*, as given by Goldfuss, are very nearly, if not quite equal, and they are slightly but uniformly curved; whereas, in the Timber Creek specimens, the sides are almost invariably unequal, the proximal and distal being considerably smaller than the lateral, and the curvature is variable in amount and direction, giving the cell a pyriform aspect. The relatively broad grooves between the cells in *Eschara dichotoma* are represented in the American species by a fine line: the mouth of both fossils is semi-circular, but more completely so in the Maestricht than the Timber Creek coral; in Goldfuss's species,

moreover, it is bounded, at the distal extremity, by a broad flat band which is extended around the whole periphery of the cell; while in Dr. Morton's coral the surface slopes inwards from the very edge of the cell.

These differences are not pointed out under the supposition that Dr. Morton conceived the two corals might be identical, for he was clearly aware of their distinction, but because both the Maestricht and Timber Creek deposits are members of the Cretaceous series, and the perfect agreement in generic outline with Goldfuss's figure (14 *a*), might lead a less careful observer than Dr. Morton to the inference, that the fossils are specifically the same.

The branches preserve a considerable uniformity of breadth, expanding only towards their bifurcation, and there very slightly, in consequence of the addition of one or more lateral rows. They diminish in thickness towards the edges, where they are rounded.

The cells on the opposite side of the medial line agree generally in position, and those forming the surface of the branches have a great regularity in size and relative proportions; but, at the point of bifurcation, and along the edges of the branches, small and imperfect cells may very frequently be observed, the latter exhibiting sometimes irregular pores in the external covering.

Of the earliest state of the cells no evidence was obtained; and of the condition after the formation of the side-walls only one case was noticed. It consisted (*a*, *b*) of a portion of a main branch, with part of another springing from a bifurcation. The surface of the greater number of the cells was wholly open, indicating considerable rapidity of development, or slowness in the formation of the exterior; and in only a few instances was there a commencement at the proximal extremity of the outer surface. The walls of the latest produced cells, or those at the superior extremity of the bifurcated branches, had a sharp edge without any line of separation; but in the cells of the undivided branch, and where the development of the external covering had commenced, fine grooves were perfectly visible. This great production of immature cells is analogous to many well-known recent examples.

In what was believed to be another step towards maturity, the surface of the cells was considerably developed, but the mouth was not regularly defined, the open part being large and circular. The structure of the mature cells is given in figure *d*, and in the specific characters.

The passages from maturity to what may be termed a state of decrepitude afforded some interesting structural details. In the first steps, the fine separating grooves between the cells were partially or completely obliterated, and a general thickening of the parietes was noticed; but these changes were not always most decidedly shown in the oldest cells of the branch, depending, apparently, in part upon the individual polype. In a specimen in which the above alterations were not so complete as in other cases, there appeared upon the surface of the cells several minute prominences, and one or two fractured vesicles. Some of the

intermediate stages were not noticed; but in specimens believed to be far advanced towards extreme age (*e*, *f*) the surface of the cells was convex, instead of being concave; all traces of lines of separation were obliterated, the mouth was irregularly shaped, sometimes with a tooth-like projection on the proximal lip, and the whole surface of the branch was beset with perforated or abraded vesicles.* No instance of a perfect filling up of the mouth, which would characterise perhaps the oldest condition of the coral, was noticed. A due preservation of the specimens, which exhibited these stages, forbade any attempt to trace a connection between the vesicles and the polype cells; but a transverse section of a mature branch exposed clearly capillary tubes, passing through the substance of the thick external covering of the cell.

The lateral and terminal foramina in the walls of the cells were well exhibited. The former, two in number (see figure *g*), were relatively large, situated near the extremities of the cell, and close to the dorsal wall. In one beautifully exposed specimen, the presumed use of these foramina in the formation of cells was instructively shown. The specimen (figure *g*) displayed the sections of a series of cells with thickened parietes, and the lateral foramina, also the rounded edge of the branch composed of a regular double row of small cells, divided longitudinally by the usual middle or dorsal layer of separation. The mouths of these cells were small and round, and might be mistaken for lateral foramina; but the boundaries of the diminutive cells, to which they were the regular openings, were clearly to be traced. The length of these imperfectly developed cells was about half that of the full-grown; and the mouths accorded in position with the situation of the lateral foramina. It is, therefore, inferred, that each minor cell was produced by means of one lateral foramen, the perfect development not having taken place, owing to the absence, in the same longitudinal row, of a full-grown anterior cell. In consequence of the quincuncial arrangement of the perfect cells, each polype had, by means of the lateral and terminal foramina, immediate connection with six other cells.

Cases of monstrosity or deviation from the normal form occur, as before mentioned, near the edges and at the bifurcation of the branches; but it is believed that some entire branches were composed of irregularly-shaped cells, and might, without care, have been assigned to a distinct species.

No traces of accessory vesicles were observed, nor any satisfactory signs of a gemmuliferous vesicle. In one case the whole surface of a cell was deeply depressed (fig. *d*), and might have formed a receptacle for the development of gemmules.

Locality. Timber Creek, New Jersey.

* These vesicles or bladders must not lead to the inference that there is any resemblance between *Eschara digitata* and the recent coral *Cellepora cervicornis*. In the former case the bladder has no regular cellular structures, while in the latter there is always a perfectly developed mouth, with accessory vesicles.

JANUARY 31, 1844.

Seymour Tremenheere, Esq., was elected a Fellow of this Society.

The following communications were read : —

1. *On the Thickness of the* LOWER GREEN SAND BEDS *of the* SOUTH EAST COAST *of the* ISLE OF WIGHT. By F. W. SIMMS, Esq., F.G.S.

THE last time the Green sand beds below the Chalk were the subject of discussion before the Society, great diversity of opinion was expressed concerning the thickness of the group of beds denominated "The Lower Green sand." To remove all doubt on this point, Dr. Fitton proposed revisiting the south-east coast of the Isle of Wight, and requested my co-operation in determining their thickness. The following vertical section of the strata, seen in the cliffs of the south-east coast of the Isle of Wight, and including the three entire groups, viz :—

1. The Upper Green Sand,
2. The Gault,
3. The Lower Green Sand,

was made in company with Dr. Fitton, Mr. Mackeson of Hythe, and the President of our Society, during a visit we made to that coast in July last

The horizontal line over which these measurements extended, that is, from Atherfield point to the Cliff on the south of St. Catherine's Down, is about three miles in length. Along nearly the whole of this line, the coast is bounded by mural cliffs, except where slips have taken place (and these are often of considerable extent), and except where "Chines" (as they are called), that is to say, deep precipitous gullies, worn by the action of brooks in the argillaceous sands, open into the sea.

Where the cliff was mural, and direct measurement was practicable, the thickness of a bed was taken by the tape or graduated rod. Where direct vertical measurement was not practicable, as, for instance, where the fall of the cliff had obscured the continuity of the beds, the spirit-level was employed, as in ordinary engineering operations. Without the aid of that instrument it would have been difficult, if not impossible, to carry on a connected series of measurement over so long a base line with any tolerable degree of accuracy. By the means employed, however, a series of vertical measures was obtained, which I consider to be a near approximation to the truth.

The apparent dip of the strata, as seen in the cliffs, and as resulting from actual measurement, near Atherfield, was to the east 2° ; but the true dip, as determined by the spirit-level at Atherfield Point, where the rocks were bare at low-water, was nearly south-east ; and its amount was found to be 2°.

The junction of the Weald Clay with the Lower Green Sand is

exceedingly well defined at Atherfield Point. That of the lower green sand with the gault, though not quite so obvious as the last-mentioned junction, is yet very satisfactorily ascertained — 1st, Below the Hotel at Black-gang-Chine, where the green sand forms a line of terrace projecting beyond the gault; 2dly, On the cliff eastward and immediately above Black-gang-Chine, where gault fossils occur at the very point of junction with the lower green sand. The junction of the gault with the upper green sand is well defined on the face of the cliff south of St. Catherine's Down, east of the Sand-Rock Spring, and above the road leading from Black-gang-Chine to Ventnor. The junction of the upper green sand with the white chalk marl is very well marked, near the summit of the same cliff.

The author stated that in the section, drawn according to scale, which accompanied this notice, he had given, not only the three principal groups, but also their more remarkable and best defined subdivisions, without pretending to describe, in needless detail, all the strata of which they are composed. From the particulars which he subjoins respecting these subdivisions, the following table is extracted : —

		ft. in.	Totals. ft. in.
Chalk Marl.			
Upper Green Sand.	Parallel layers of a soft rock, "hassock," which rapidly disintegrates by exposure; and of hard cherty sandstone, which, after weathering, stands out in high relief	37	
	Sand, with beds of stone and chert	67	
			104
Gault.	Light-coloured gault, becoming gradually bluer	43	
	Beds of decided blue colour. No fossils have been found, except in the very lowest beds	103	
			146
Lower Green Sand.	Lower green sand. No notice required	384	
	Bed containing oysters and Gryphœa	21	
	Various beds not noticed	269	
	A bed of argillaceous sand, containing large lenticular, concretionary masses of very hard calcareous sandstone, locally termed "the crackers." These masses, when broken, are found to contain numerous fossils	15	
	Blue argillaceous beds, the lowest of which approach in their character to fullers-earth. The upper of these beds contain Crustacea; the lower contain remains of Pinna. In the latter respect, these beds agree with the clay that lies beneath the sand and stone at Hythe in Kent, described in the paper read before the Society in June last. If this bed be the equivalent of the clay bed at Hythe, the crackers will represent the stone-beds at Hythe, decribed in the same paper. They also agree with the Hythe stone-beds, in being very nearly at the same vertical distance above the Wealden. For the purpose of comparison, the Hythe section has been drawn to the same scale as that of the Isle of Wight	59	
	Atherfield rock, containing many fossils	2 2	
	Dark greenish sandy clay, looking black when wet, containing many of the same fossils as the rocky bed	2 9	
			752 11

2. Report *on the* Lower Green sand Fossils *in the Possession of the Geological Society.* By Professor Edward Forbes, F.L.S.

The collection of Lower Green Sand fossils at present in the cabinets of the Society contains 131 species of Mollusca. Of these 82 are Lamellibranchiate Bivalves, 12 Brachiopoda, 23 Gasteropoda, and 14 Cephalopoda. Besides these, all well-marked species, there are a number of casts and fragments of species as yet undetermined.

Of the 131 Mollusca, 60 are additions to the list of Lower Green sand Fossils, published by Dr. Fitton in the "Geological Transactions." Of these 60 additional species, between 30 and 40 are undescribed forms. The remainder are species described in the memoirs of Leymerie, D'Orbigny, Roemer, and other continental authors, but which have been hitherto unrecorded as British, with the exception of a few included in Mr. Morris's catalogue.

All the species have been critically examined, and characters drawn up of such as are new.

The collection can by no means be regarded as complete, numerous additions, including several very beautiful species, having been very lately presented to the Society; and these there has not as yet been time to examine and place in the cabinets.

Of the lower green sand Mollusca in the collection, 35 agree with Neocomien species recorded by M. Leymerie, and about 30 with species from the Hillsthon and Hillsconglomerat of M. Von Roemer. Many species, which had received new names from those geologists, have proved, on examination, to be well-known British species, figured in the Mineral Conchology or elsewhere. Among these are several which are regarded on the Continent as characteristic of the so-called Neocomien beds.

Of Radiata, there are in the collection about 12 speeies of Polyparia and Amorphozoa, and 9 Echinodermata; of Annelida 8 or 9 species, and several Crustacea. Additions to this part of the collection are very desirable, especially better specimens of Echinodermata.

To complete the collection, fossils from the Speeton Clay, of which there are none in the Society's possession, are much wanted. The table now drawn up exhibits the species at present in the collection, and their relation to the French lower green sand fauna, and to that of Germany, as well as the British localities in which they have occurred. It appears from this table that the greater number of species are as yet only known as fossils of British strata.

[*Note.* It has been thought advisable to publish this report in its present form in the "Proceedings," as a record of what was done at the time. The catalogue referred to, enriched by many additions, and accompanied by figures of new species, will, it is hoped, be shortly placed in the possession of the Fellows of the Geological Society.—Ed.]